Fig. 1

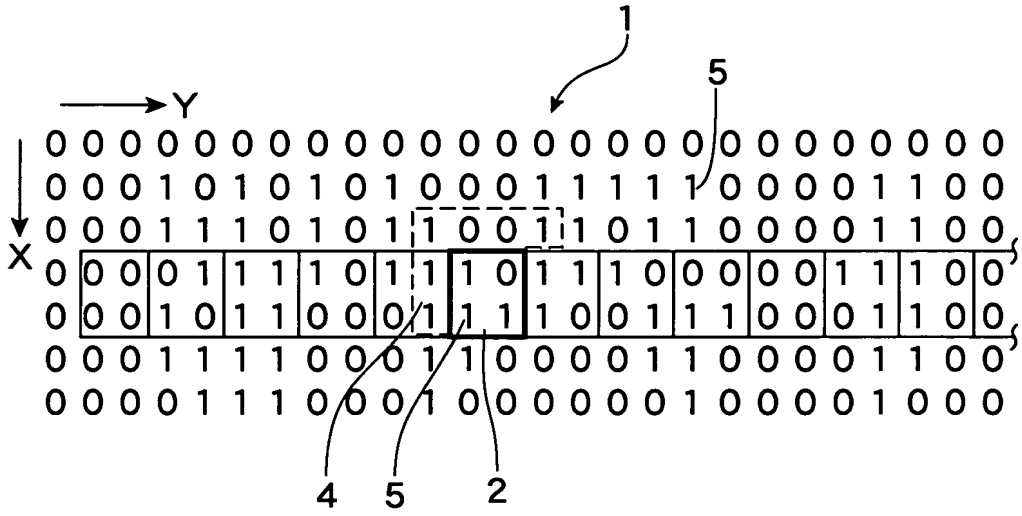

1
5
Y
X
4
5
2

Fig. 2

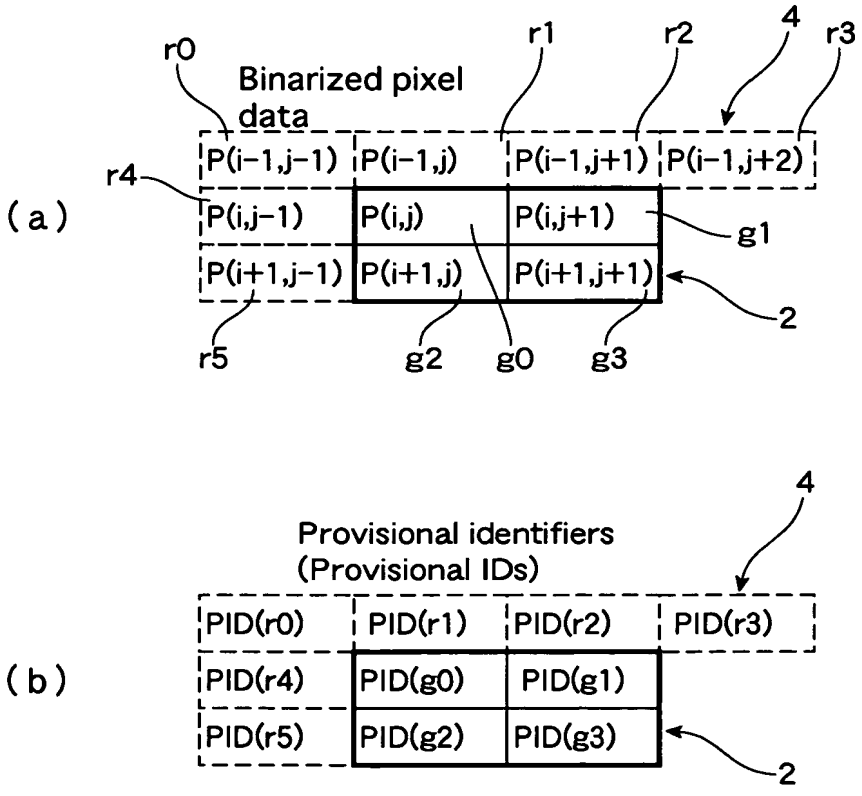

(a)
r0
Binarized pixel data
r1
r2
4
r3
r4
P(i-1,j-1)
P(i-1,j)
P(i-1,j+1)
P(i-1,j+2)
P(i,j-1)
P(i,j)
P(i,j+1)
g1
P(i+1,j-1)
P(i+1,j)
P(i+1,j+1)
2
r5
g2
g0
g3
(b)
4
Provisional identifiers (Provisional IDs)
PID(r0)
PID(r1)
PID(r2)
PID(r3)
PID(r4)
PID(g0)
PID(g1)
PID(r5)
PID(g2)
PID(g3)
2

Fig. 3

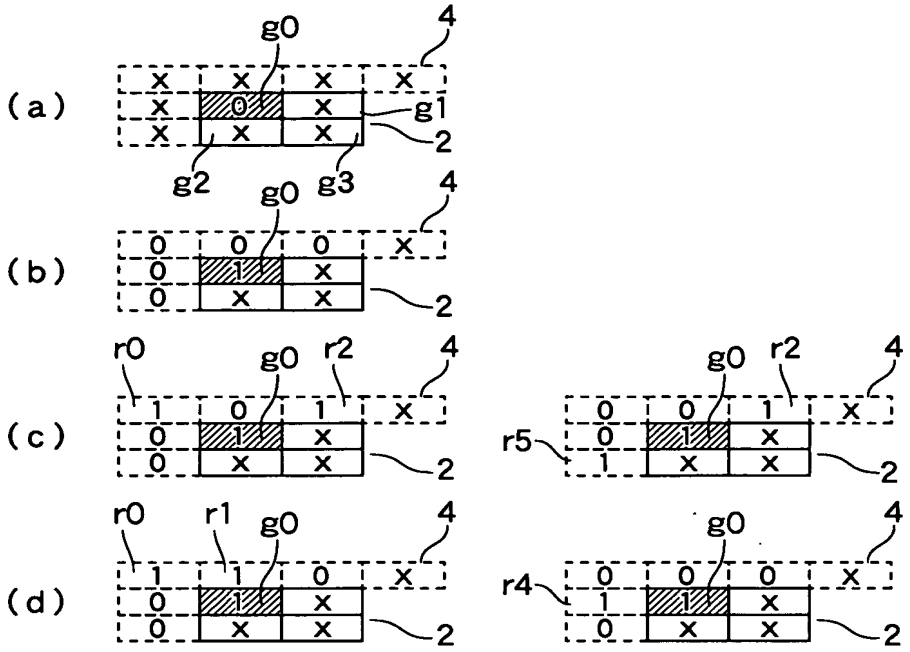


Fig. 4

g0		g1	2 g2	g3	r0	r1	r2	r3	r4	4 r5	
Pixel block					Adjacent pixel group						
P(i,j)	P(i,j+1)	P(i+1,j)	P(i+1,j+1)		P(i-1,j-1)	P(i-1,j)	P(i-1,j+1)	P(i-1,j+2)	P(i,j-1)	P(i+1,j-1)	
0	0	0	0		0	0	0	0	0	0	Nop
1	0	X	X		1	1	1	0	1	1	Combination #1
1	1	X	X		1	1	1	1	1	1	Combination #2
0	1	0	X		0	1	1	1	0	0	Combination #3
0	1	1	X		0	1	1	1	1	1	Combination #4
0	0	1	X		0	0	0	0	1	1	Combination #5
0	0	0	1		0	0	0	0	0	0	New label

Fig. 5

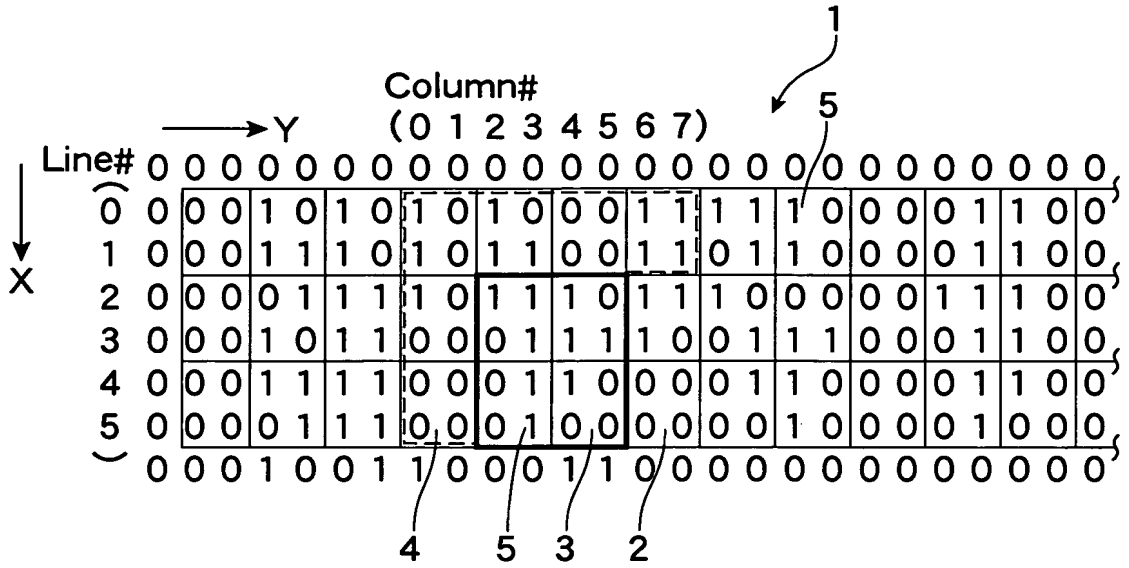

1
Column#
(0 1 2 3 4 5 6 7)
Y
X
Line#
5
4
5
3
2

Fig. 6

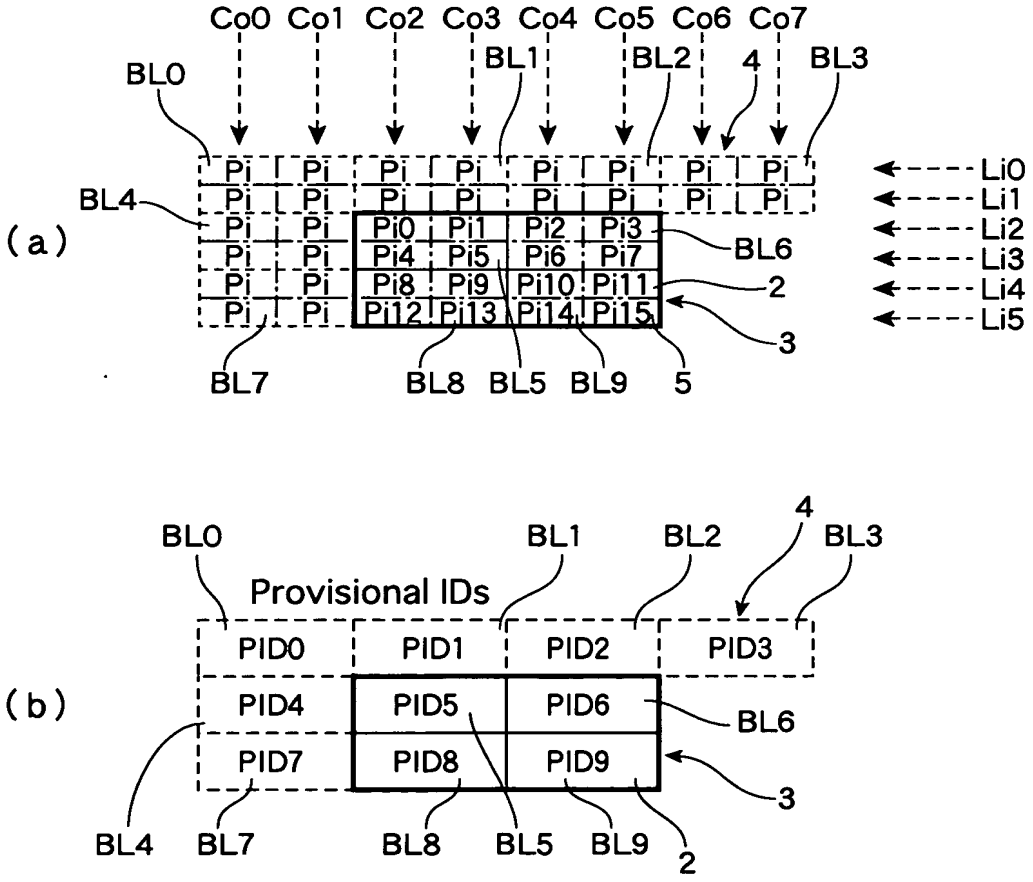

Co0 Co1 Co2 Co3 Co4 Co5 Co6 Co7
BL0
BL1
BL2
4
BL3
BL4
Pi
Pi0 Pi1 Pi2 Pi3
Pi4 Pi5 Pi6 Pi7
Pi8 Pi9 Pi10 Pi11
Pi12 Pi13 Pi14 Pi15
BL6
2
3
BL7
BL8
BL5
BL9
5
Li0
Li1
Li2
Li3
Li4
Li5
(a)
Provisional IDs
PID0 PID1 PID2 PID3
PID4 PID5 PID6
PID7 PID8 PID9
(b)

Fig. 7

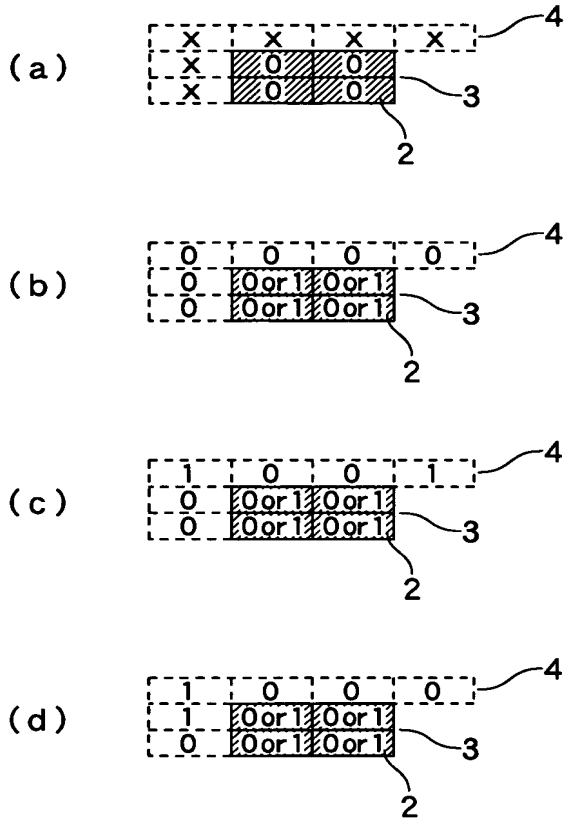

(a)
X X X X
X 0 0
X 0 0
4
3
2
(b)
0 0 0 0
0 0or1 0or1
0 0or1 0or1
4
3
2
(c)
1 0 0 1
0 0or1 0or1
0 0or1 0or1
4
3
2
(d)
1 0 0 0
1 0or1 0or1
0 0or1 0or1
4
3
2

Fig. 8

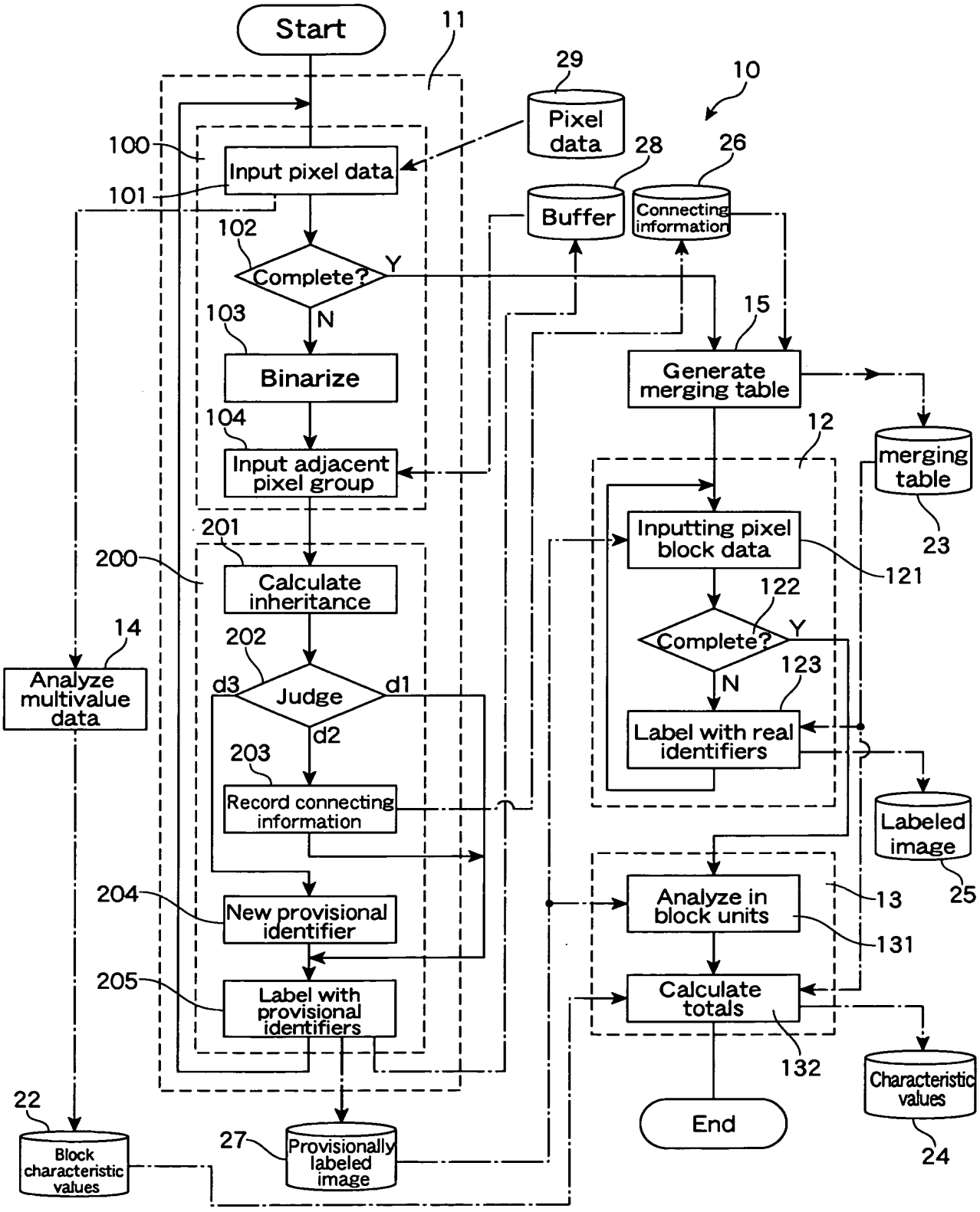

Start
11
29
Pixel data
10
100
Input pixel data
28
26
101
Buffer
Connecting information
102
Complete?
Y
N
103
15
Binarize
Generate merging table
104
12
merging table
Input adjacent pixel group
201
Inputting pixel block data
200
Calculate inheritance
121
23
122
14
Complete?
Y
202
N
123
Analyze multivalue data
d3
Judge
d1
d2
Label with real identifiers
203
Record connecting information
Labeled image
25
204
Analyze in block units
13
New provisional identifier
131
205
Calculate totals
Label with provisional identifiers
132
Characteristic values
22
End
27
24
Block characteristic values
Provisionally labeled image

Fig. 9

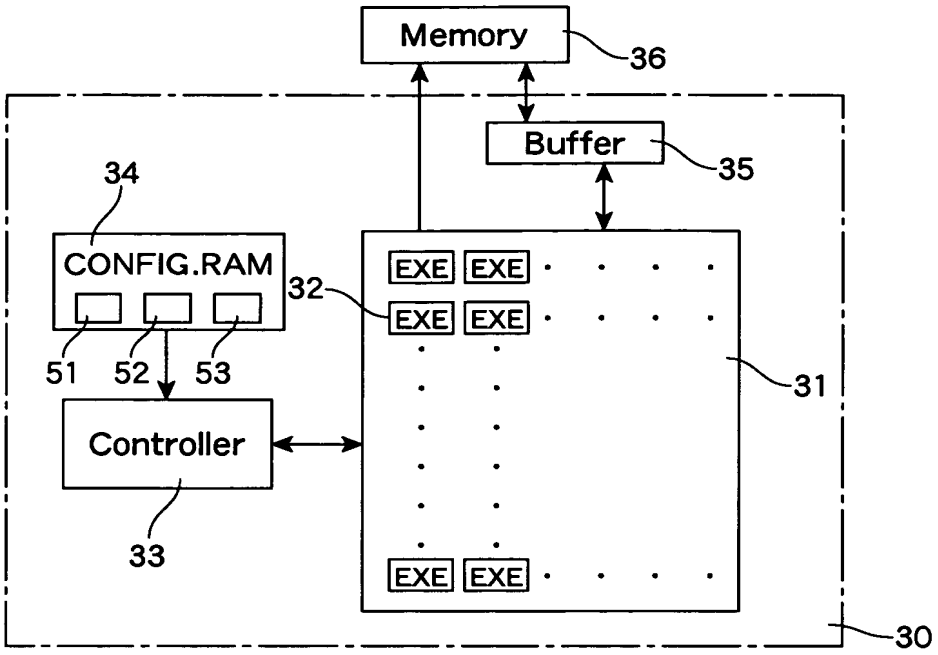
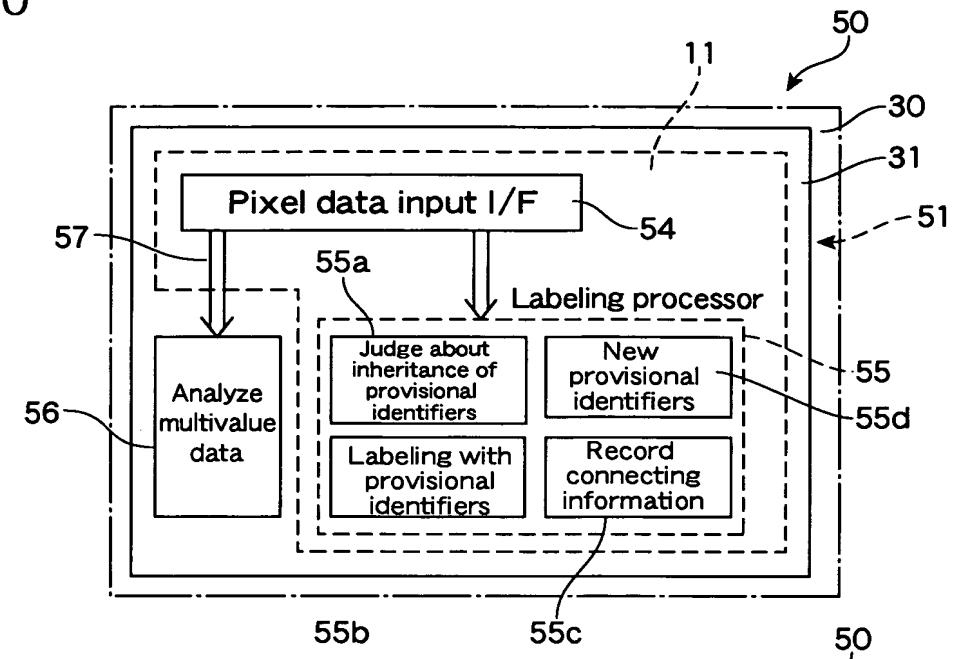
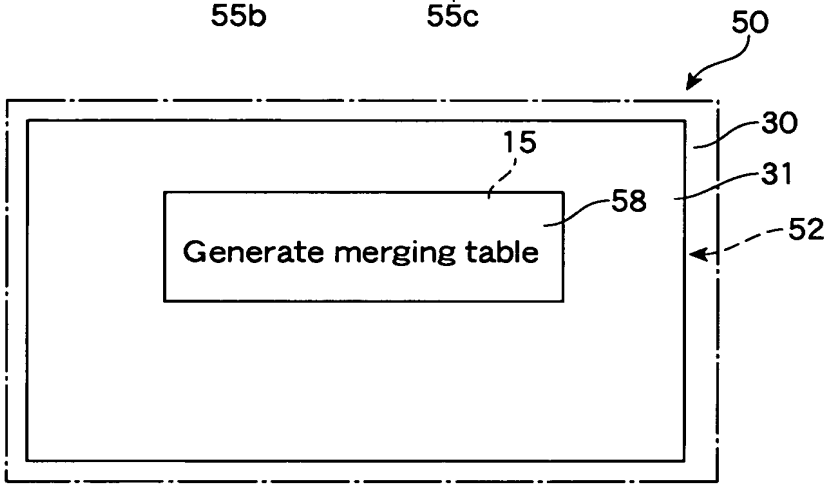

Memory
36
Buffer
35
34
CONFIG.RAM
32
51
52
53
Controller
33
EXE
31
30

Fig. 10

(a)


50
11
30
31
51
Pixel data input I/F
54
57
55a
Labeling processor
Analyze multivalue data
56
Judge about inheritance of provisional identifiers
New provisional identifiers
55
55d
Labeling with provisional identifiers
Record connecting information
55b
55c

(b)


50
30
15
31
58
Generate merging table
52

(c)

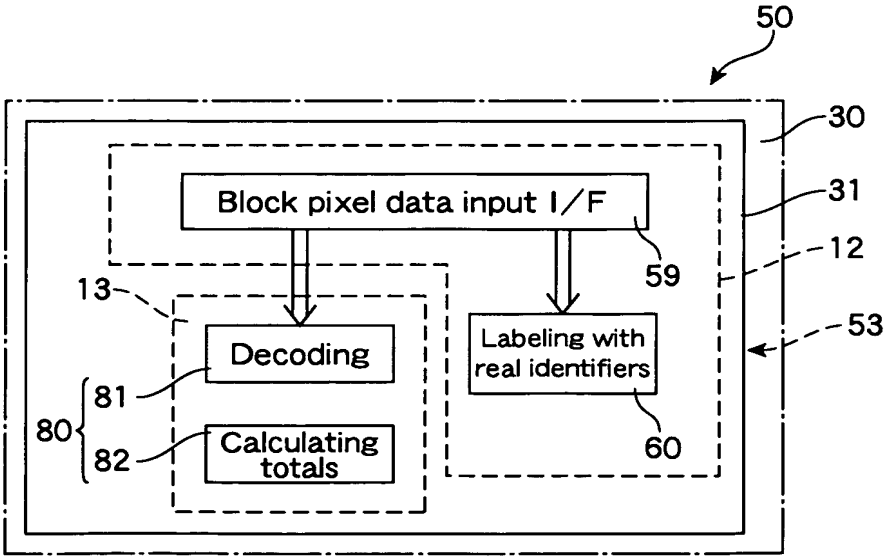

50
30
Block pixel data input I/F
31
59
12
13
Decoding
Labeling with real identifiers
53
81
80
82
Calculating totals
60

Fig. 11

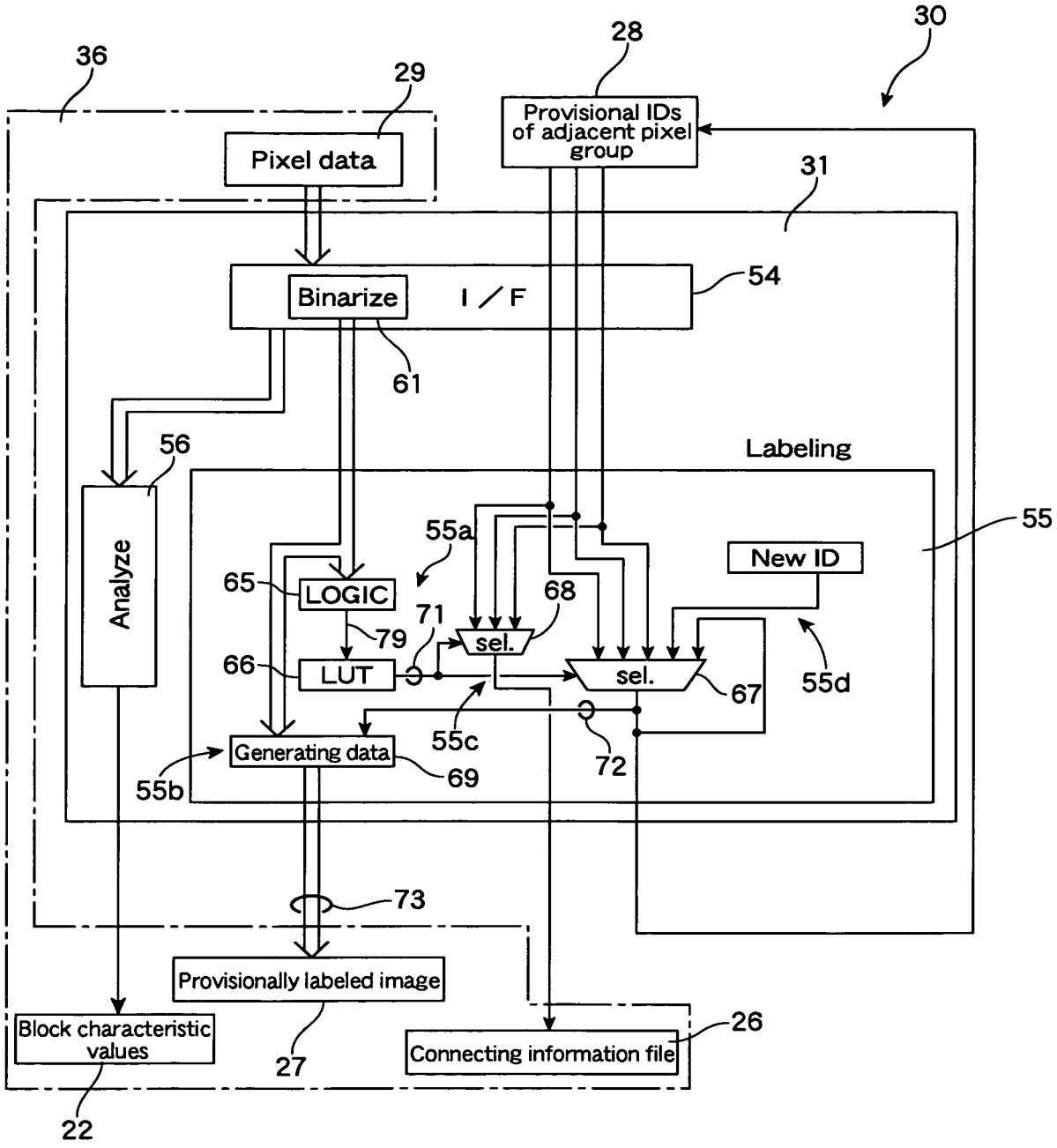

30
28
36
29
Provisional IDs of adjacent pixel group
Pixel data
31
Binarize
I / F
54
61
56
Labeling
Analyze
55a
55
New ID
65
LOGIC
68
71
79
sel.
66
LUT
sel.
67
55d
55c
72
Generating data
69
55b
73
Provisionally labeled image
Block characteristic values
27
Connecting information file
26
22

Fig. 12

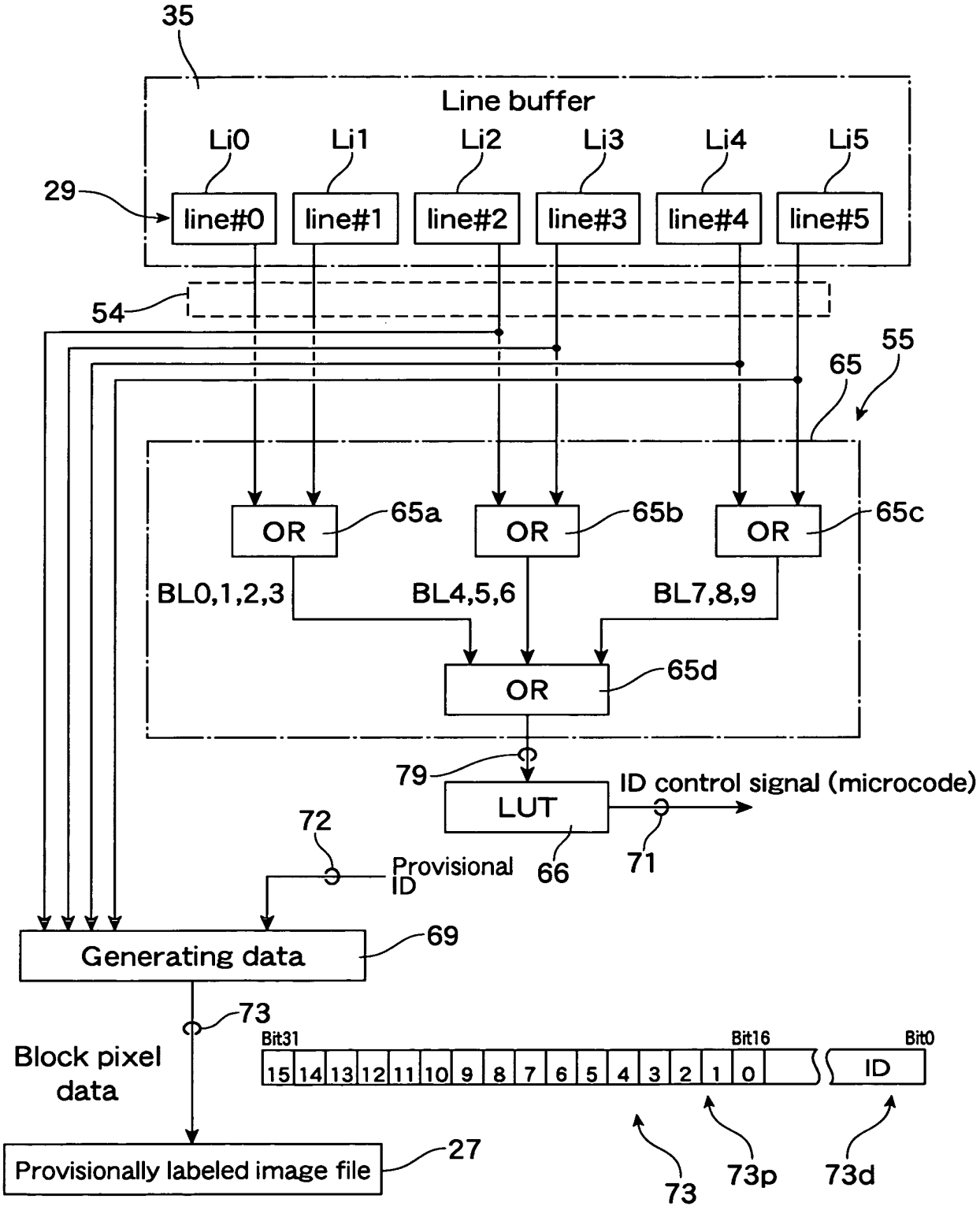

35
Line buffer
Li0
Li1
Li2
Li3
Li4
Li5
29
line#0
line#1
line#2
line#3
line#4
line#5
54
55
65
OR
65a
OR
65b
OR
65c
BL0,1,2,3
BL4,5,6
BL7,8,9
OR
65d
79
LUT
ID control signal (microcode)
72
Provisional ID
66
71
Generating data
69
73
Block pixel data
Bit31
Bit16
Bit0
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
ID
Provisionally labeled image file
27
73
73p
73d

Fig. 13

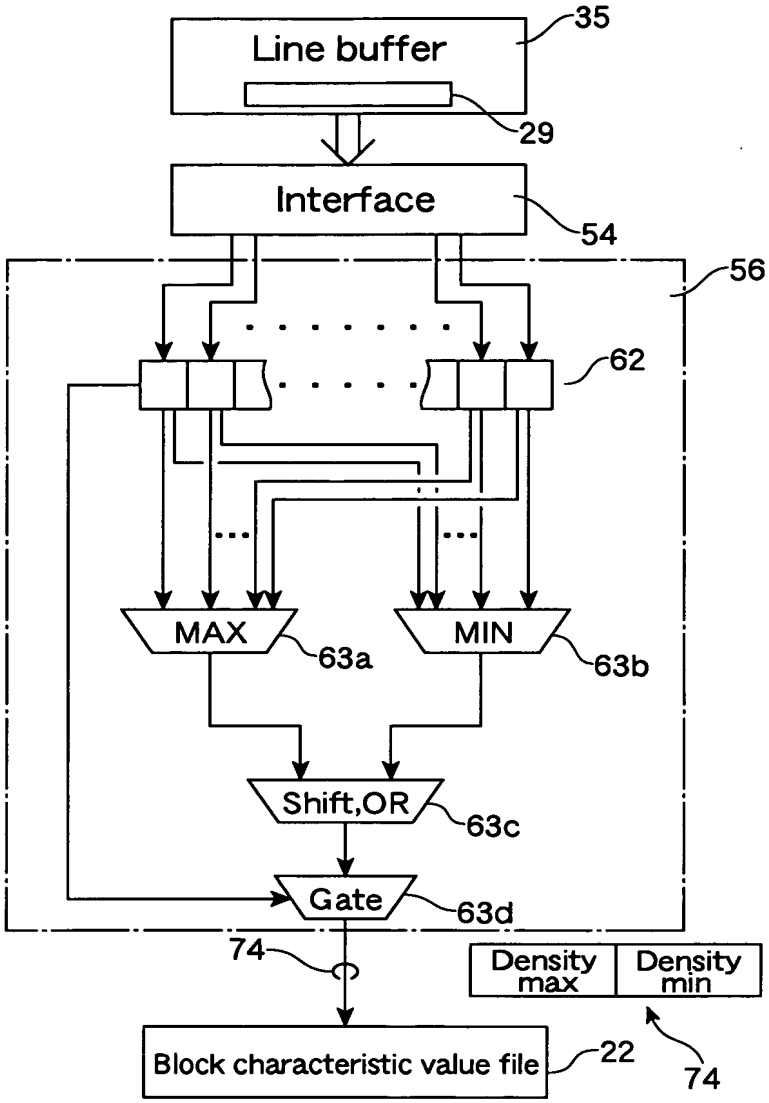

Line buffer
35
29
Interface
54
56
62
MAX
63a
MIN
63b
Shift,OR
63c
Gate
63d
74
Density max
Density min
Block characteristic value file
22
74

Fig. 14

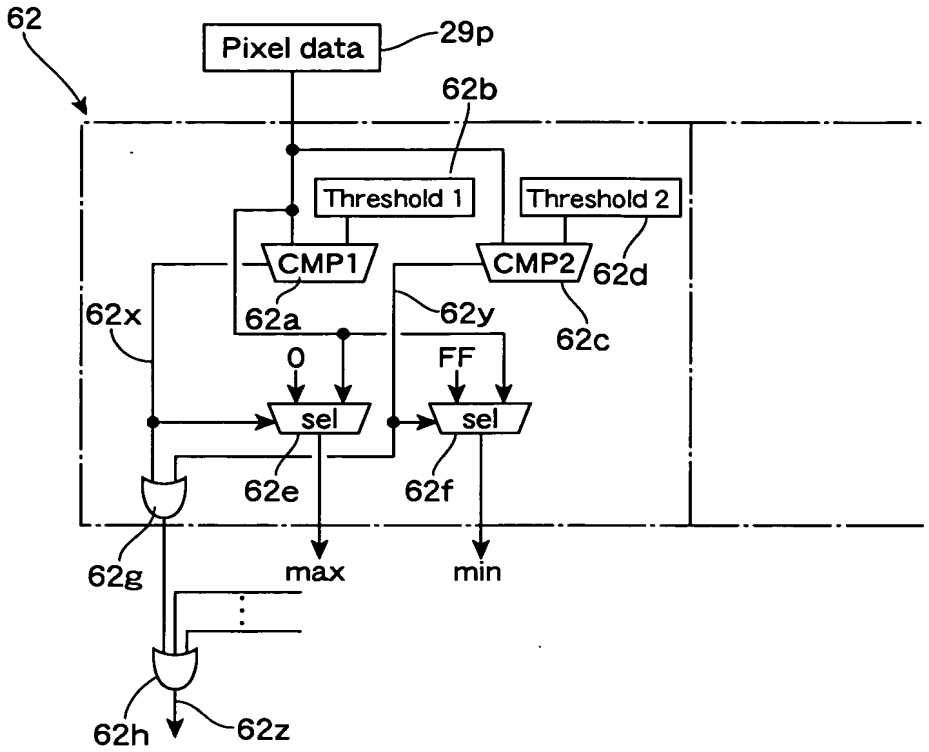

62
Pixel data
29p
62b
Threshold 1
Threshold 2
CMP1
CMP2
62d
62x
62a
62y
62c
0
FF
sel
sel
62e
62f
62g
max
min
62h
62z

Fig. 15

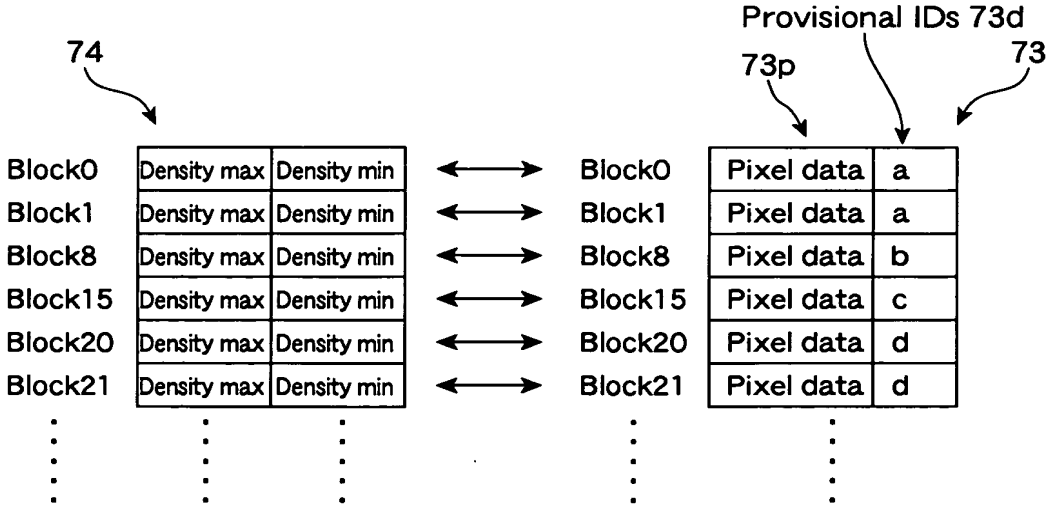

74
Provisional IDs 73d
73p
73
Block0 Density max Density min
Block1 Density max Density min
Block8 Density max Density min
Block15 Density max Density min
Block20 Density max Density min
Block21 Density max Density min
Block0 Pixel data a
Block1 Pixel data a
Block8 Pixel data b
Block15 Pixel data c
Block20 Pixel data d
Block21 Pixel data d

Fig. 16

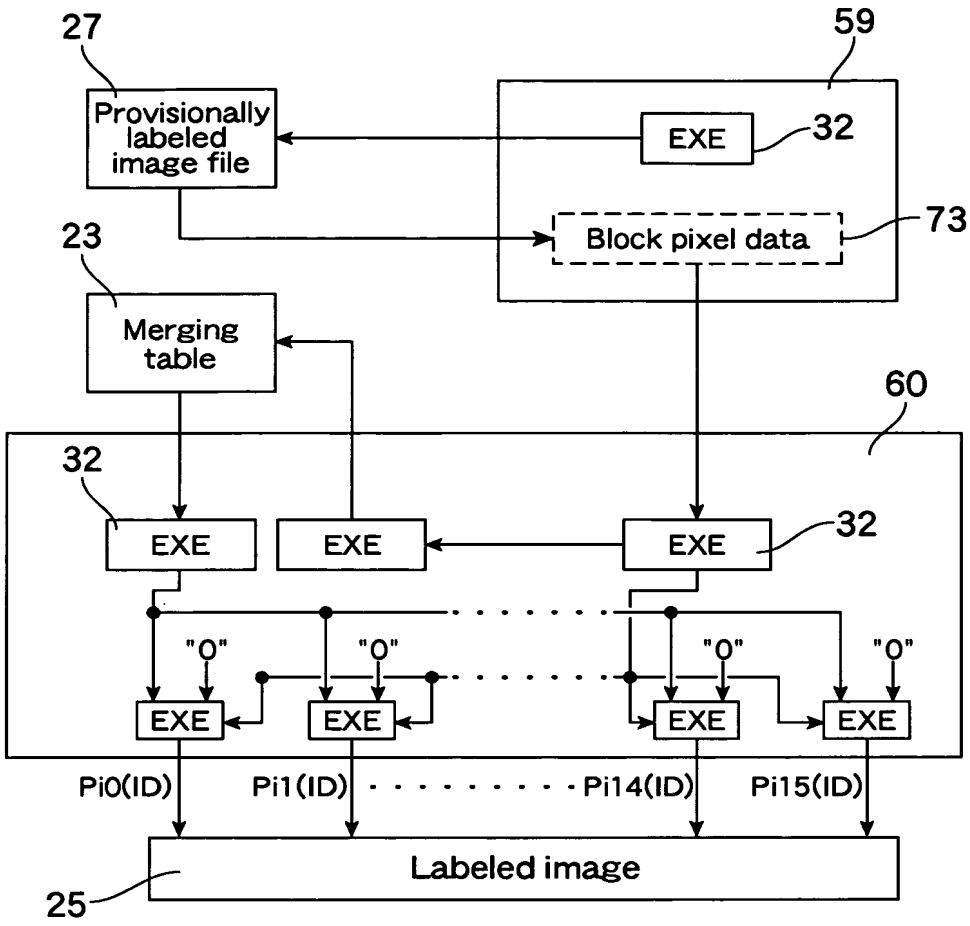
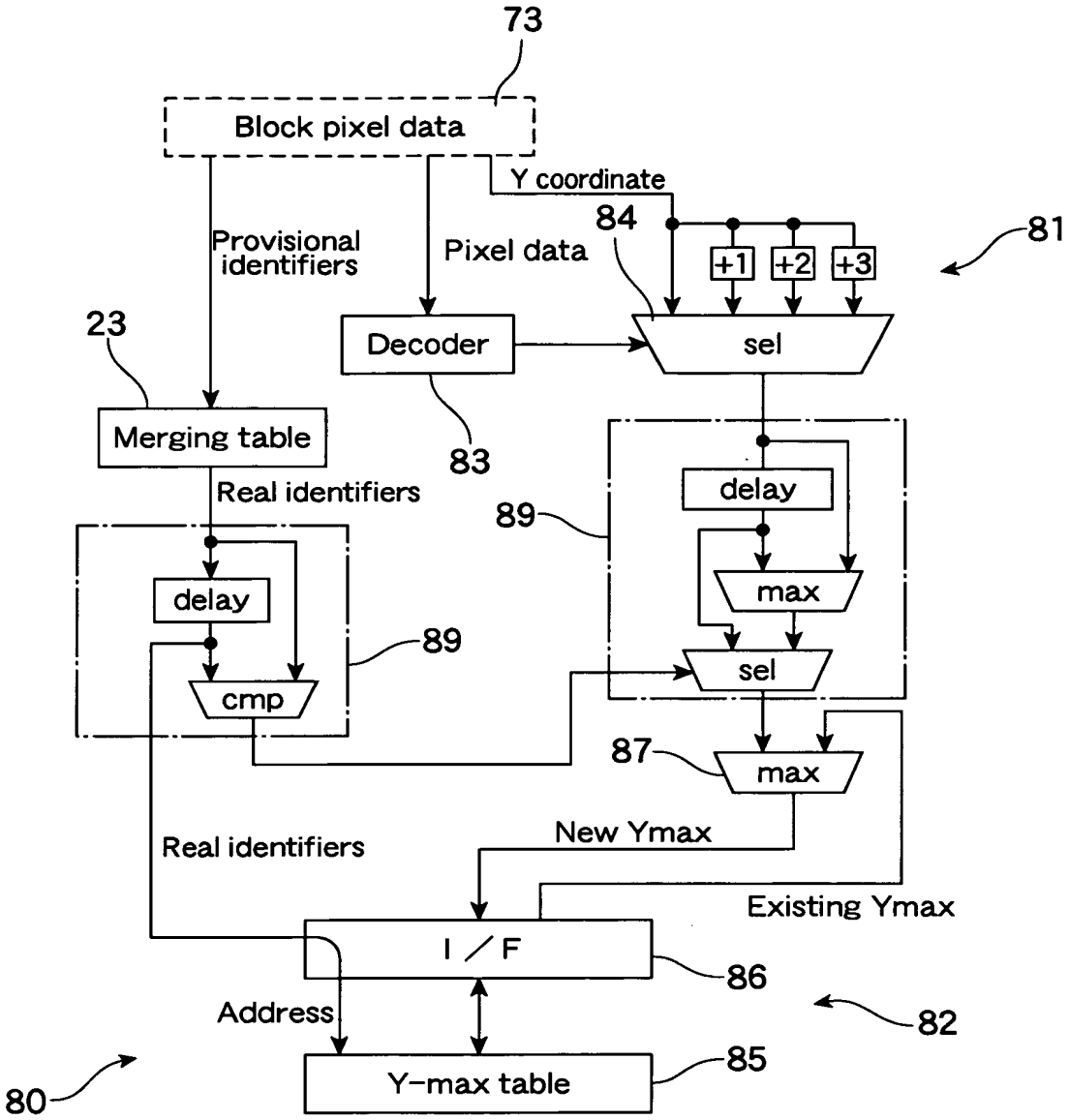

27
59
Provisionally labeled image file
EXE
32
Block pixel data
73
23
Merging table
60
32
EXE
EXE
EXE
32
"0"
"0"
"0"
"0"
EXE
EXE
EXE
EXE
Pi0(ID)
Pi1(ID)
Pi14(ID)
Pi15(ID)
Labeled image
25

Fig. 17


73
Block pixel data
Y coordinate
84
81
Provisional identifiers
Pixel data
+1
+2
+3
23
Decoder
sel
Merging table
83
Real identifiers
delay
89
max
delay
89
sel
cmp
87
max
Real identifiers
New Ymax
Existing Ymax
I / F
86
82
Address
85
Y-max table
80